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Comments on Environmental Remediation at Idaho National Engineering and Environmental Laboratory

Idaho Chemical Processing Plant Radioactive Waste Management Complex

submitted on behalf
Environmental Defense Institute
by
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A cursory review of the available US Geological Survey (USGS) reports related to Idaho National Engineering and Environmental Laboratory (INEEL) flooding scenarios and flood control infrastructure, it is clear that additional analysis is needed prior to any final siting decisions are made for new waste internment and disposition of existing buried waste. Specifically, a two dimensional model is needed to expand the existing USGS one dimension model to include the upper 95% confidence flow estimates of 11,600 cubic feet per second for the Big Lost River 100-year flood, and include modeling for the upper range limit of the 500 year estimated flow rate in the Big Lost River flood plain on the INEEL.

Department of Energy (DOE) appears to be prepared to meet regulatory requirements and construct a Resource Conservation Recovery Act (RCRA) Subtitle C hazardous waste dump called the INEEL CERCLA Disposal Facility (ICDF), however, the choice to locate it at the Idaho Chemical Processing Plant (ICPP) is misguided for the same reason that leaving the contaminated soils and the sediments in the high-level waste tanks, and buried waste at the Radioactive Waste Management Complex (RWMC) is misguided.

The reason why locating the ICDF at the ICPP - especially underground - is because the northern part of the ICPP lies in the 100 flood plain of the Big Lost River. DOE's plan is to locate the ICDF near or on top of the ICPP percolation ponds which are immediately south of the perimeter fence. The ICPP as a whole is about as flat as a table top with only a couple feet change in elevation north to south. The USGS released a study in 1996 estimated the flow range for the Big Lost River at the INEEL. "The upper and lower 95-percent confidence limits for the estimated 100-year peak flow were 11,600 and 3,150 cubic feet per second (cf/s), respectively." [1]

Since 1950, INEEL has experienced significant flooding events in1962, 1969, and 1982. In an effort to mitigate the flooding problem, the site built a diversion dam on the Big Lost River that is designed to shunt flood waters to the south and away from INEEL facilities. USGS released another report 1998 that modeled the mean (mid-range) 100-year flow rate of 7,260 cf/s upstream of the INEEL diversion dam.. USGS estimated that the Big Lost flow rate downstream of the diversion dam at 6,220 cf/s with a thousand cf/s going down the diversion channel for a total median flow rate of 7,260 cf/s upstream of the INEEL diversion dam. [2] "This peak flow was routed down stream [of the Big Lost River] as if the INEEL diversion dam did not exist. On the basis of a structural analysis of the INEEL diversion dam (U.S. Army Corps of Engineers) the dam was assumed incapable of retaining high flows. The Corps indicated that the diversion dam could fail if flows were to exceed 6,000 cubic feet per second."[3] This study acknowledged that the northern half of the ICPP would be flooded with four feet of moving water, even at this mid-range (mean) flow rate.

Since the radioactive waste will be extremely hazardous for tens of thousands of years and

[1] Estimated 100-Year Peak Flows and Flow volumes in the Big Lost River and Birch Creek at the Idaho National Engineering Laboratory, Idaho, U.S. Geological Survey, Water-resources Investigations Report 96-4163, L.C. Kjelstrom and C. Berenbrock, 1996, page 9.

[2] Preliminary Water-Surface Elevations and Boundary of the 100 Year Peak Flow in the Big Lost River at the Idaho National Engineering and Environmental Laboratory, Idaho, US Geological Survey, Water-resources Investigations report 98-4065, DOE/ID-22148

[3] USGS 98-4065, page 8

flooding will flush contaminates down into the aquifer, a conservative risk assessment would model the upper 95-percent confidence limits for the estimated 100-year peak flow of 11,600 cf/s. USGS has proposed this additional research to DOE, but the Department thus far is not willing to provide the funding. A USGS hydrologist notes, "The flow of 11,600 cfs represents the upper 95 percent confidence limit flow for the estimated 100-year peak flow (Kjelstrom and Berenbrock, 1996, p6). Future modeling needs are to model the area with this flow. We've expressed this to the INEEL and also have expressed that the WSPRO model used has limitations and that an application of more stringent models (two dimensional) is needed to refine and better delineate the extent of possible flooding of the Big Lost River." [4]

USGS estimates the mean 500-year Big Lost River flood rates at 9,680 cf/s (34% greater flow rate than the mean 100 year flood).[5] This 500-year flood would inundate the ICPP and surrounding area. These potential hazards must be taken into consideration when making hazardous mixed radioactive waste decisions in these vulnerable areas because of the long-term consequences and the potential for additional aquifer contamination.

Cascading events should also be considered. This is known as a worst case scenario where one event triggers another event. For instance a 500-Year flood plus failure of Mackay Dam (built in 1917) resulting in estimated flows of 9,700 + 54,000 cubic feet per second respectively would be an example of a cascading event. Failure of Mackey Dam is non-speculative in view of the recent failure of the Teton Dam of similar construction and the fact that Mackey Dam lies within 6 kilometers of a major earthquake fault line that produced the Borah Peak 7.5 quake. USGS did not consider cascading events but noted previous studies showing that failure of Mackay Dam alone would result in 6 feet of water at the INEEL Radioactive Waste Management Complex (RWMC). Other studies recognized by USGS note that, "Rathburn (1989, 1991) estimated that the depth of water at the RWMC, resulting from a paleo-flood [early] of 2 to 4 million cf/s in the Big Lost River in Box Canyon and overflow areas, was 50-60 feet." "If Mackey Dam failed, Niccum estimated that peak flow at the ICPP would be at 30,000 cfs." [6] Comparing these flow rates with the USGS estimate 100-year mean flow of 6,220 cfs that would flood the north end of the ICPP with four feet of water, and a Mackey Dam failure becomes a real disaster potential with respect to the buried waste at the ICPP.

DOE is relying extensively on the Big Lost River Diversion Dam to shunt major flood waters away from INEEL facilities. The last comprehensive analysis of this diversion dike system (below the diversion dam) was conducted by USGS in 1986 in a report titled *Capacity of the Diversion Channel below the Flood Control Dam on the Big Lost River at the INEL*. In this study USGS estimated a mean flow rate of 9,300 cf/s, 7,200 of which went into the diversion channel and "2,100 cf/s will pass through two low swells west of the main channel for a combined maximum diversion capacity of 9,300 cf/s." "A sustained flow at or above 9,300 cf/s could damage or destroy the dike banks by erosion. Overflow will first top the containment dike at

[4] Charles E. Berenbrock, U.S. Geological Survey Hydrologist, March 25, 1999 email to Chuck Broscious

[5] Estimated 100 Year Peak Flows and Flow Volumes in the Big Lost River and Birch Creek at the Idaho National Engineering Laboratory, U.S. Geological Survey, Water Resources Investigations Report 96-4163, page 11 shows flow rates for 5-year, 10-year, 100-year, and 500-year floods

[6] USGS 98-4065, page 6

cross section 1, located near the downstream control structure on the diversion dam." [7] This USGS study did not analyze the construction of the diversion dikes but they would likely fail as did the upstream diversion dam, built at the same time, that the Army Corps of Engineers found deficient. "On the basis of a structural analysis of the INEEL diversion dam (U.S. Army Corps of Engineers, written comments, 1997), the dam was assumed incapable of retaining high flows. The Corps indicated that the diversion dam could fail if flows were to exceed 6,000 cf/s. Possible failure mechanisms are: (1) erosion of the upstream face of the dam that results from high-flow velocities and loss of slope protections (rip-rap), (2) overtopping of the diversion dam by flows exceeding the capacity of the diversion channel and culverts, (3) piping and breaching of the diversion dam because of seepage around the culverts, and (4) instability of the dam and its foundation because of seepage."[8]

Failure of the diversion dam and/or the diversion channel dikes would directly impact the Radioactive Waste Management Complex (RWMC) burial grounds. A 1976 USGS report notes, "The burial ground is within 2 miles (3.2 km) of the Big Lost River and the surface is approximately 40 feet (12 m) lower than the present river channel. Sediments in the burial ground contain grains and pebbles of limestone and quartzite, suggestion that in recent geologic past, flood waters of the Big Lost River flowed through the burial ground basin. Two eroded notches or 'wind-gaps' in the basalt ridge bordering the west of the burial ground also suggest past Big Lost River floods." "A large diversion system on the Big Lost River was constructed by the AEC to control flood waters by diverting water into ponding Areas A, B, C, and D. The nearest of these, Area B is less than a mile [south] from and about 30 feet (9m) higher in elevation than the burial ground." [9]

USGS *Arco Hills SE* and *Big Southern Butte* quadrangle topographic maps clearly show the RWMC flooding vulnerability as do other USGS reports that note, "If [diversion] dike 2 [at ponding Area B] fails, large flows will drain directly [north] toward the solid radioactive waste burial grounds." [10] These vulnerabilities must be taken into consideration when DOE attempts to leave the buried transuranic waste at the RWMC and not exhume and relocate it to a safe permanent repository.

Building dams around the proposed INEEL CERCLA Disposal Facility (ICDF) as was done at the RWMC is not an acceptable flood protection answer because lateral water migration will go under the dams and local precipitation will be held in exacerbating the leachate conditions. The liner of the ICDF will not be capable of maintaining integrity with the increased hydraulic pressure during a flood because they are only capable of blocking what minimal surface water may

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[7] Capacity of the Diversion Channel Below the Flood Control Dam on the Big Lost River at the Idaho National Engineering Laboratory, US. Geological Survey Water Resources Investigations Report 86-4204, C. M. Bennet, page 1 and 25

[8] USGS 98-4065, page 9

[9] Hydrology of the Solid Waste Burial Ground, as Related to the Potential Migration of Radionuclides, Idaho National Engineering Laboratory, U.S. Geological Survey, Open File Report 76-471, J.Barraclough, August 1976, page 8

[10] Probability of Exceeding Capacity of Flood-Control System at the National Reactor Testing Station, Idaho, U.S. Geological Survey Water Resources Division, P.Carrigan, JR., 1972, page 4

leak past the cap and infiltrate the waste. There are good legitimate reasons why dumps are not allowed by statute in flood zones. Dams by definition are only functional if there is regular maintenance which cannot be assumed once DOE ends institutional control of INEEL in a hundred years. Dumping the waste on top of the ground and mounding the cover over it will result in the cap eroding over the long-term which again is unacceptable. Regulator's contention that there is a degree of efficiency in co-locating the ICDF with the ICPP percolation ponds that themselves must be remediated along with the "windblown" soil contamination area around the percolation ponds not only defies common sense but is also illegal. DOE must designate another location for the ICDF that is not near a flood plain and preferably not over the aquifer. DOE's own study has identified at least two such sites where the Lemi Range meets the Snake River Plain. [11]

Nuclear Regulatory Commission restrictions prohibiting citing radioactive waste disposal dumps on 100 year flood plains must be observed. [NRC 10 CFR ss 61.50] The reason for these restrictions is because the flood water will leach the contaminates out of the waste and flush the pollution more rapidly into the aquifer. Since these wastes will remain toxic for tens of thousands of years, they must be disposed of responsibly in a safe permanent repository. These issues must be kept in mind also with respect to the ICPP high-level waste tanks that are some forty feet underground as well as the underground spent reactor fuel storage and calcine storage bins at the ICPP. Water acts as a moderator and if the underground spent fuel vaults are flooded, it could cause a criticality. All of these underground high-level waste sites are extremely vulnerable. Former ICPP workers recall stacking sandbags six feet high around the plant during a Spring flood about ten years ago.

The ICDF Engineering Design and Waste Acceptance Criteria (WAC) must be developed with public involvement through a free and open discussion. Only un-containerized wastes that can be compacted during placement should be allowed so as to minimize subsidence caused by container decomposition. Biodegradable, VOC, collapsible, soluble, TRU, or Greater than Class C Low-level, and Alpha-low-level waste must also be excluded from the ICDF dump and sent off-site. Prior to completing the ICDF Title II Design, workshops should be convened for stakeholders to comment on the proposal. Waste Acceptance Criteria maximum contaminate concentration levels must be determined from waste sampling prior to being mixed with any stabilizing materials. In other words, "dilution is not the solution to pollution".

USGS reports identified factors favoring downward waste migration. "In order for waste isotopes to be carried downward by water, four basic requirements are needed: 1.) availability of water, 2.) contact of the water with the waste, 3.) solubility or suspendability of the waste in water, 4.) permeability in the geologic media to allow water flow downward." [12] This report describes in detail how all four conditions are met at INEEL including the solubility factor where they note "Hagan and Miner (1970) leached five different categories of solid waste from Rocky Flats [the main source of plutonium in the RWMC] with ground water from the INEL and Rocky Flats and measured the plutonium concentrations and pH of the leachate. They found the highest

[11] Moriarty, T. P., Feasibility of Locating Dry Storage of Spent Nuclear Fuel on Idaho National Engineering Laboratory Land at a Site That Does Not Overlie the Snake River Aquifer, November 1995

[12] USGS 76-471 page 68-69

Pu-239 concentration in leachates from the acidic-graphite wastes, 62,000 to 80,000 ug/l plutonium or (3.8×10^9 to 4.9×10^9 pCi/L)." [Ibid]

The most reliable indicators of contaminate migration are onsite sampling data. Cesium-137, plutonium-238,-239,-240 were all found at the 240 foot interbeds under the RWMC. [IDO-22056@74] Forty-one % of the samples from the 240 foot interbeds contained radionuclides. [Ibid.@87] Other literature confirmation of plutonium at 240 feet includes: "Radionuclides (including Pu-238.-239.-240, Am-241, Cs-137, Sr-90) have been detected in soils and in sedimentary interbeds to a depth of 240 feet beneath the RWMC, (Hodge et al, 1989)." "Positive values for Pu-238,-239,-240 were detected in samples obtained from the 240 foot interbed in bore hole DO2."[DOE/ID-10183@134-145][DOE/ID/12082(88) @14-16] Radionuclides are also confirmed in the aquifer under the RWMC. [EG&G-WTD-9438@25] USGS water sampling data at the 600 foot levels, expressed in pico curies per liter (pCi/l) show:

Groundwater Sampling Data at 600 Feet Under RWMC

Nuclide	Concentration pCi/L	Drinking Water Std. pCi/L
Tritium	10,000.00	20,000.00
Cobalt-57	48.00	1,000.00
Cobalt-60	100.00	100.00
Cesium-137	400.00	119.00
Plutonium-238	9.00	7.02
Plutonium-239-240	0.14	62.10
Americium-241	15.00	6.34
Strontium-90	10.00	8.00

[IDO-22056 @66] * The drinking water standard for gross alpha (total of all alpha emitters) is 15 pCi/l.

USGS report titled *Hydrology of the Solid Waste Burial Ground as Related to the Potential Migration of Radionuclides Idaho National Engineering Laboratory* , describes in detail the monitoring well drilling methodology. USGS hydrologists that drilled the wells went to considerable lengths to ensure surface or near-surface contamination did not compromise their 600 foot deep well samples listed in the table above. Analysis of the circumstances of the RWMC generated the following principal evidence supporting migration of radionuclides to the aquifer below.

> "Sufficient water has come in contact with buried waste to cause initial leaching and mobilization. Sufficient quantities of wastes have been available for leaching to account for observed subsurface radionuclide concentrations. The lithologic column beneath the burial ground has sufficient permeability and appears to be at field moisture capacity; this would allow infiltrated water to have migrated downward. Sufficient water has percolated downward through the burial ground to have reached depths were significant concentrations of

radionuclides were found. Most of the higher subsurface radionuclide concentrations tended to lie beneath the oldest buried waste or beneath the areas through which the most water has percolated. A greater percentage of samples analyzed from the 110 foot sedimentary layer contained waste isotopes than from the 240 foot or deeper layers in the six interior wells. Samples from wells 93 and 96 indicate greater concentrations of nuclides in the 110 layer than in the 240 foot layer. Many of the observed subsurface concentrations of radionuclides were greater than could be attributed to artificial sample contamination from any known ground-surface or other overlying sources." [IDO-22056@83]

DOE's own sampling of the USGS 600 foot wells at the RWMC between 1987 and 1997 show americium-241 contamination at levels shown in the following table. Americium-241 is a decay product (daughter) of plutonium-241. The maximum concentration level allowed in drinking water is 6.34 pCi/l. Though the DOE sample concentration levels for Am-241 are lower than those of USGS, the data contradicts DOE public statements for the past several decades that actnides (isotopes heavier than uranium) had migrated to the aquifer which is 580 feet below the RWMC.

Americium-241 at 600 foot level at RWMC

Well Number	Date of Sampling	Concentration (pCi/l)
88	1992	0.40 +/- 0.02
89	1990	0.04 +/- 0.02
90	1988	0.06 +/- 0.03
90	1990	0.04 +/- 0.02
117	1987	0.06 +/- 0.03
119	1991	0.06 +/- 0.03
M-1F	1997	1.03 +/- 0.27
M-10-S	1993	0.3 +/- 0.1
M-3F	1997	0.045 +/- 0.017

[Hain(a)]

US Geological Survey (USGS) hydrologist Barraclough estimates that 100 acre-feet (32,492,910 gallons) of direct precipitation landed on the RWMC between 1952 and 1970. Additionally, due to the low depression of the RWMC local run off has entered the burial ground adding to direct surface water introduction. The 1962 flood which inundated the SDA allowed 30 acre feet (10,000,000 gallons) into the SDA. The 1969 flood put 20 acre feet (6.4 million gallons) into the SDA. [IDO-22056@46] It is no wonder radionuclides are found in the Snake River Aquifer. "Adams and Fowler measured solubilities of plutonium in tap water and found a range of 46,000 to 130,000 pCi/l."... "These findings are also consistent with Hagan and Miners (1970)." [Ibid.@70] According to DOE sponsored studies, the presence of gamma radiation increases the permeability/leach-ability of contaminates in basalt by ten-fold. [EG&G-J-02083] Water samples taken in the flooded SDA pits during the 1969 flood contained 13,000 pCi/l gross beta and 2,700 pCi/l gross alpha. [IDO-22056@69-70] This data verifies the solubility of radionuclides and the water sample data from the deep monitoring wells verify the mobility of these contaminates. Additionally, USGS soil samples under Pit 10 showed plutonium at 400,000 pCi/g and under Pit 2 the Pu was at 320,000 pCi/g which confirms contaminate mobility.[IDO-22056@77]

Flooding of the RWMC and its Subsurface Disposal Area (SDA) from the Big Lost River has occurred at least three times (1962, 1969, and 1982) since 1950. In 1962, Trenches 24 and 25 plus Pits 2 and 3 were flooded. In 1969, Trenches 48 and 49 plus Pits 8, 9, and 10 were flooded. In 1982, Trenches 42 and 49 plus Pit 16 were flooded. [EG&G-WM-10090@3] According to topographical map (INC-B-15368) of the burial ground area and a part of the Big Lost River ponding areas, the burial ground lies 40 feet below the Big Lost River 2 miles north. [IDO-22056@8] A flood-control diversion dam was been built to mitigate flooding. A USGS 1976 "Analysis of historical stream-flow information indicate that floods in the Big Lost River would overtop the flood-control diversion dam about once in every 55 years on average; if the culverts in the dam are completely plugged, overtopping of the dam would occur about once every 16 years." [IDO-22052@iii] The 1982 flooding of the SDA was in fact caused by plugging of the culverts. [EG&G-WM-10090] Since the RWMC is the lowest point in the region, there is nowhere else for the water to go. Currently, sump pumps are required to remove water out of the RWMC due to its lack of drainage. [IDO-22056 @10] This drainage problem begs the question of long-term institutional control to prevent flooding after DOE is gone.

Winter of 1996-97 brought record (188%) snow pack that feeds the Big Lost River coupled with record high Spring temperatures that again raise the flooding risks. Brandon Lommis, Idaho Falls Post Register reporter, found that in addition to the RWMC flooding hazard, the ICPP high-level waste tanks are also at risk. Lommis reports that, "Mike Bennett, INEEL's water resources coordinator, said 'it would be foolish not to have some concerns,' and that dike failure could allow water to seep into the underground storage tanks under a chemical processing plant and possibly contaminate the Snake River Plain Aquifer, according to a recent study. INEEL officials this year asked the Army Corps of Engineers to help inspect the dam and dikes before the water peaks. Bennett said dirt graders and trucks are standing by to shore up any unexpected weak spots." [Post Register 5/7/97] The May 20, 1997 LMICO Star noted that:

> "Under normal conditions, the diversion dam is adequate to control water flow. The dam is weakest above the diversion gate, and may need reinforcement if water flows become heavier than anticipated (flood waters could flow over the diversion dam and back into the Big Lost river bed). Dixon has identified a source of rip rap (large rocks) and gravel for reinforcement. Along with the rip rap and gravel, 9,000 sandbags are strategically stockpiled to expedite any reinforcement that becomes necessary. The sandbags include 4,000 in existing inventory with another 5,000 bags ordered and available if needed." [Star (d)]

Geologic investigations are needed on the ground up stream of the INEEL diversion dam to see if there is evidence of flooding and related heights/volumes. This type of information may minimize the uncertainty of long-term maximum flood projections (i.e.. validate flow-rate assumptions). The life expectancy evaluations are also needed of the Big Lost River diversion dam and related channels, dams etc., after the 100 year institutional control and maintenance of the flood control infrastructure ends. Absent maintenance, could debris collect and block the interconnecting channels to the spreading areas facilitating the failure of the dams, and thus flood the RWMC? The USGS believes this is a credible scenario in their 1976 report.

> "It would appear that a rare major flood of the [Big Lost] river could over-flow into the burial ground basin through the narrow wind-gaps in the basalt. Although this has not occurred in the INEEL history, evidence indicates it has occurred in the past 2,000 years and possibly within the past 200 years." "At regional scale, horizontal hydraulic conductivities of the Snake River Plain Aquifer generally range from 100 to 10,000 feet per day as determined from well pumping tests or flow net analysis. The high number is among the highest for any know aquifer."... "Although vertical hydraulic conductivity is generally much less than horizontal conductivity in basalt, significant vertical conductivity does exist, primarily through vertical fractures. This is demonstrated by the fact that surface water from the Big Lost River infiltrates from the channel and the INEL diversion area and produces measurable recharge to the aquifer. In addition, waste water recharged to the Test Reactor Area (TRA) disposal ponds eventually reaches the Snake River Aquifer, 450 feet below. There is no reason to believe that basalt beneath the burial ground have significantly less hydraulic conductivity than those beneath TRA or the diversion area." "Specified field tests...at Test Area North vicinity of the INEEL indicated an average horizontal permeability of about 55 feet per day and vertical permeability of about 15 feet per day." [IDO-22056@48]

A hypothesis is needed of Mackey Dam being overtopped and failing due to floods of not much greater recurrence interval than that of the maximum floods considered in the literature. The results of a failure of Mackey Dam have not been investigated in this paper. The INEEL EIS acknowledges that Mackey Dam "was built without seismic design criteria" and "additionally, it is not clear how resistant the dam structure is to seismic events" and the fact that "a fault segment runs within 6 kilometers of the Mackay Dam" [DEIS @ B-17] is significant. One need only recall the catastrophic failure of the Teton Dam a few years ago northeast of Idaho Falls. The Teton Dam, also constructed by the Army Corps of Engineers, failed because of inadequate design and construction. A 1996 DOE Environmental Assessment (EA) for TAN Pool Stabilization noted that the maximum probable flood is considered conservative as the last flood (12,000 years ago) with the magnitude of 35,000 cubic feet per second.[DOE/EA-1050 @B-4] This flood would easily overflow the diversion dam capacity of 9,300 cubic feet per second.

A 1993 USGS report titled *Speciation of Plutonium and Americium in Ground Waters from the Radioactive Waste Management Complex* notes: "The solubility of plutonium, when added in the low-osidation-state form [Pu(III) and (VI)], did not exceed 50 percent (of the amount added) in any of the waters from wells that penetrate the Snake River Plain Aquifer." "In water from well 92, however, which is completed in a perched aquifer at a much shallower depth than the water table, 83 percent of the Pu(III) and (VI) remained in solution 30 days after it was added." "In experiments using the high oxidation states Pu(V) and (VI), virtually all the added plutonium remained in solution in the water from all wells, and remained in the relatively soluble high oxidation states." "The results indicate that although low-oxidation-state plutonium is generally insoluble in water [50%] from the Snake River Plain Aquifer, it is more soluble in water from the perched aquifer and could, in time, be leached from the waste and ultimately reach the Snake River Plain Aquifer." The report goes on to note that the reason for the increased solubility of plutonium in the perched water is due to the 222,000 gallons of hazardous wastes including acids and solvents were also dumped in the RWMC.[13] The solubility of actnides and there mobility is a big issue with the ICPP high-level waste tanks contaminated soils because this resulted from raffinate (nuclear fuel processing waste) leaks which transuranics are already dissolved in a acid/solvent solution and therefore highly mobile. Flooding of the ICPP would therefore result in extensive migration of contaminates to the underlying aquifer.

Radioactivity of Waste Dumped at the Subsurface Disposal Area 1952-1983

Major Generator	RWMIS Shipping Record Roll up (curies)
Test Area North	63,000
Test Reactor Area	460,000
ID Chemical Processing Plant	690,000
Naval Reactors Facility	4,200,000
Argonne-West	1,100,000
Rocky Flats Plant	57,000
Other	55,000
Total	11,000,000

[EGG-WM-10903 @ 6-25]

The above summary of radioactive content of waste dumped is considered understated. The Environmental Defense Institute analysis of the curie content of Navy shipments to the burial ground, for instance, adds up to 8,140,668 curies. However the above DOE data using annual summaries attributes the Navy to only 4.2 million curies or only half as much. DOE admits that the annual summaries are understated. [EGG-WM-10903 @ 6-26]

[13] Speciation of Plutonium and Americium in Ground Waters from the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, U.S. Geological Survey, Water Resources Investigations Report 93-4035, J. Cleveland, A. Mullin, 1993, page 1

Chemical Contaminates in the Dissolved and Suspended Fractions of Ground Water from Selected Sites, Idaho National Engineering Laboratory and Vicinity, Idaho 1989, U.S. Geological Survey, Open File Report 92-51, pg 33, shows organic solvents under RWMC

Plutonium in Groundwater at the NTS: Observations at ER-20-5, J.L.Thompson, A.B. Kersting, D. Finnegan, Chemical Technology Division, Los Alamos National Laboratory, Isotope Sciences Division Lawrence Livermore National Laboratory, December 1997, that shows extensive plutonium migration at the Nevada Test Site

Selected Rocky Flats Waste Dumped at the Subsurface Disposal Area, 1954-1972

Radionuclide	Lower Bound Estimate	Upper Bound Estimate
Plutonium (all species)	1,102 kilo grams	1,455 kilo grams
Americium-241	44 kilo grams	58 kilo grams
Uranium-235	386 kilo grams	603 kilograms

[ER-BWP-82 @A-4]

References:

IDO-22052; Probability of Exceeding Capacity of Flood Control System at the National Reactor Testing Station, US Geological Survey, P. Carrigan, Jr., January 1972, TID-4500

IDO-22054; Digital Modeling of Radioactive and Chemical Waste Transport in the Snake River Plain Aquifer at the National Reactor Testing Station, Idaho, J. Robertson 1974

IDO-22056; Hydrology of the Solid Waste Burial Ground, as Related to the Potential Migration of Radio nuclides, INEL, J. Barraclough et al., US Geological Survey, August 1976, Open File Report 76-471

IDO-22062; Evaluation of a Predictive Ground-Water Solute Transport Model at the INEL, ID, B. Lewis et al., USGS, 1982

DOE/ID-10087-87; Effluent Information System/On-site Discharge Information System, 1987 Executive Summary, September 1988 DOE ID Operations Office

DOE/ID-10087-85; Effluent Information System/On-site Discharge Information System, 1985 Executive Summary, September 1986 DOE ID Operations Office

DOE/ID-10183; INEL Pit 9 Remedial Investigation Feasibility Study Vol. II Administrative Record

DOE/ID-10527; Work Plan for Waste Area Group 1, Operable Unit 1-10, Comprehensive Remedial Investigation / Feasibility Study, Idaho National Engineering Laboratory, US Department of Energy Idaho Operations Office, DOE-ID-10527, March 1996.

DOE/ID-10531; Comprehensive Remedial Investigation/Feasibility Study for the Test Reactor Area, Operable Unit 2-13 at the Idaho National Engineering Laboratory, 1996, Lockheed Idaho Technologies Company, Idaho Falls, ID

DOE/ID-10544; Regulatory Analysis and Proposed Path Forward for INEL High-level Waste Program, Nuclear Operations Division High-level Waste Directorate, U.S. DOE Idaho Operations, 10/96. Hereinafter called DOE-ID-10544

DOE/ID-10557; Comprehensive Remedial Investigation / Feasibility Study for the Test Area North Operable Unit 1-10, Idaho National Engineering Laboratory, US Department of Energy Idaho Operations Office, DOE-ID-10557, November 1997

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DOE/ID-22071; Capacity of the Diversion Channel Below the Flood Control Dam on the Big Lost River at the Idaho National Engineering Laboratory, US Geological Survey, Investigations Report 86-4204, C. Bennett, October 1986

DOE/ID-22109; Statistical Summaries of Streamflow Data for Selected Gaging Stations on and near the Idaho National Engineering Laboratory through 1990, US Geological Survey Investigations Report 92-4196, M. Stone, L. Mann, L.Kjelstrom, 1993

DOE/ID-22124; Radionuclides, Stable Isotopes, Inorganic Constituents, and Organic Compounds in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering Laboratory to the Hagerman Area, Idaho 1994, U.S. Geological Survey Open File Report 95-718, October 1995, R. Bartholomay, L. Williams

DOE/ID-22125; Chemical Constituents in Water from Wells in the Vicinity of the Naval Reactors Facility, Idaho

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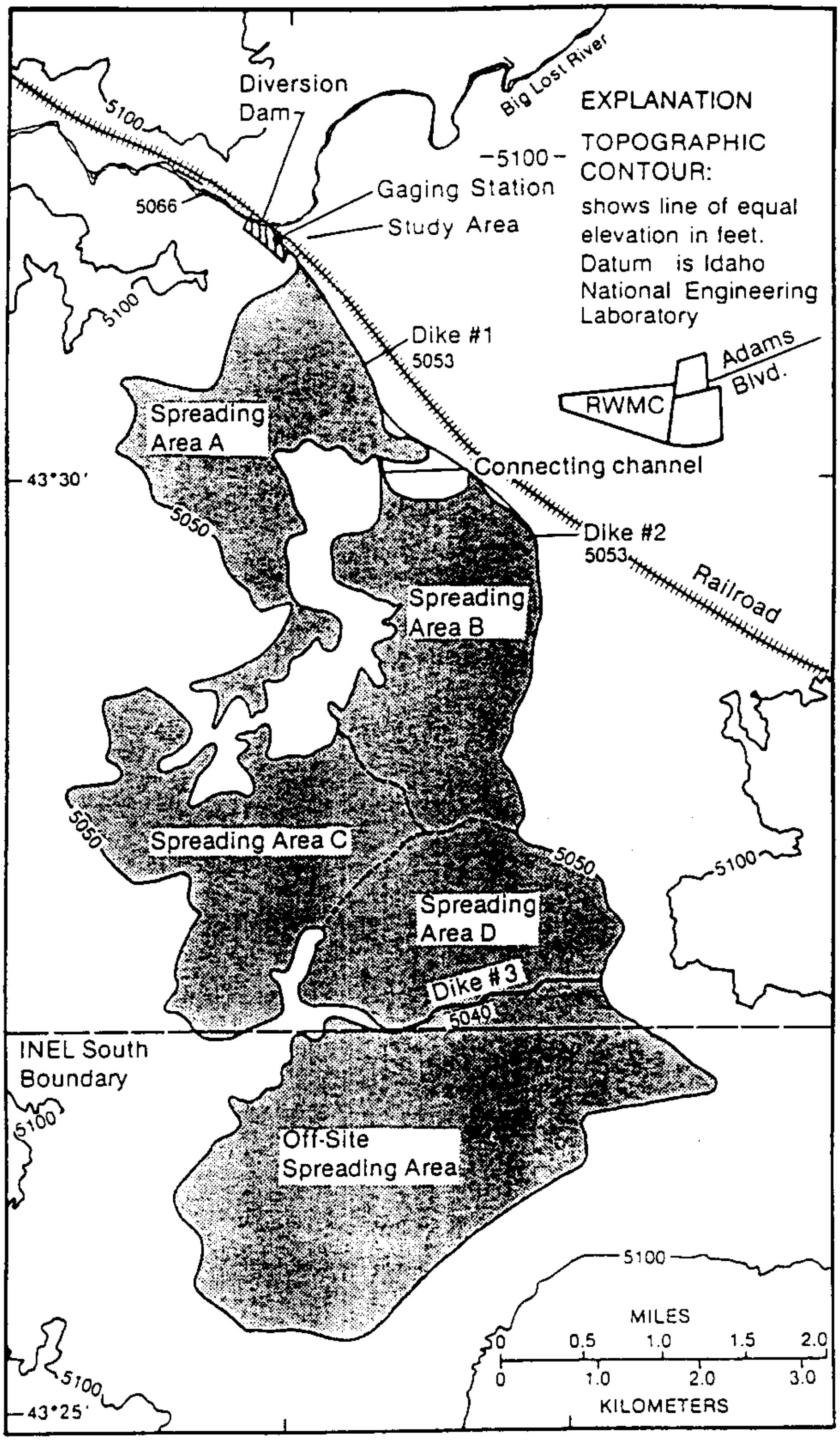
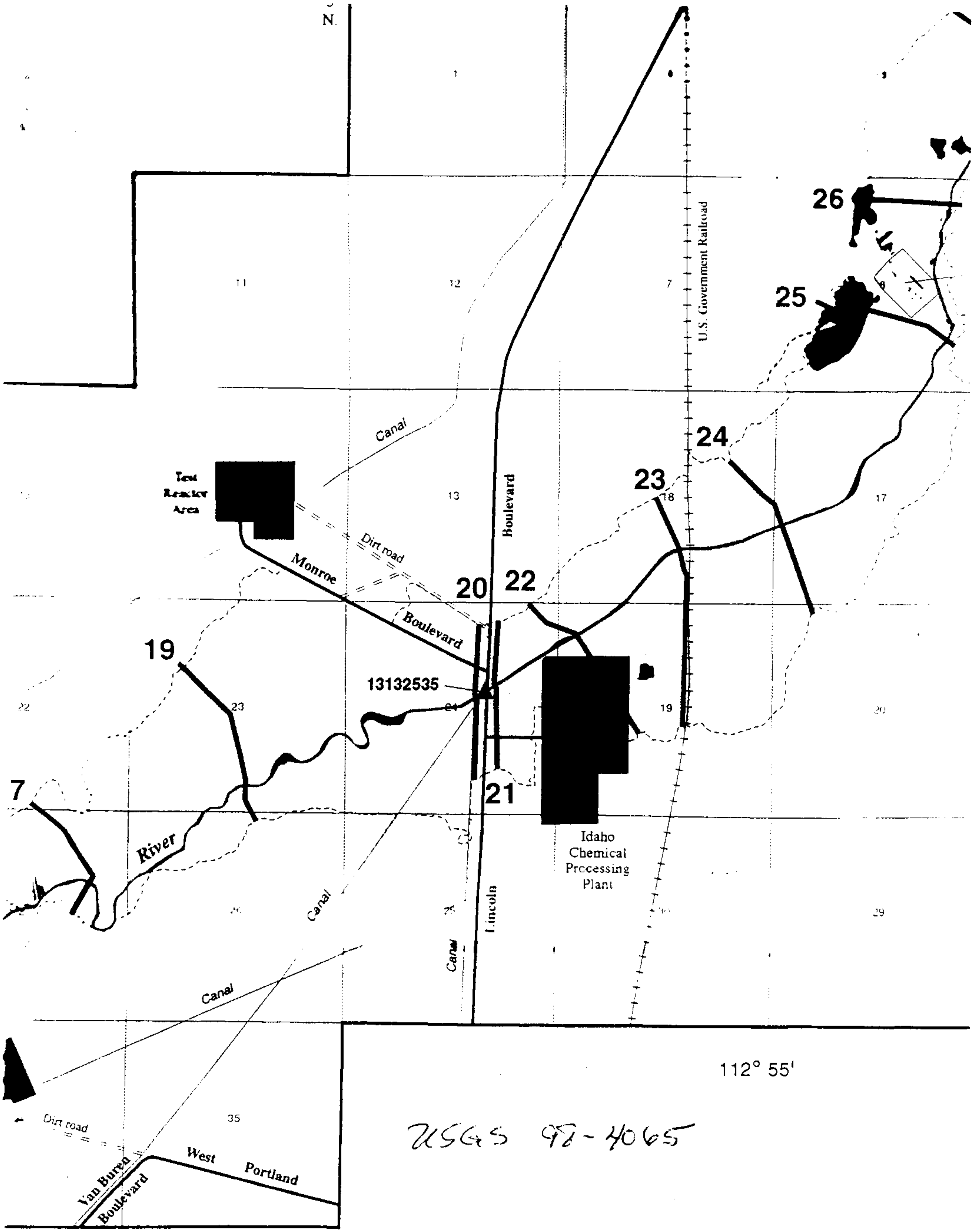
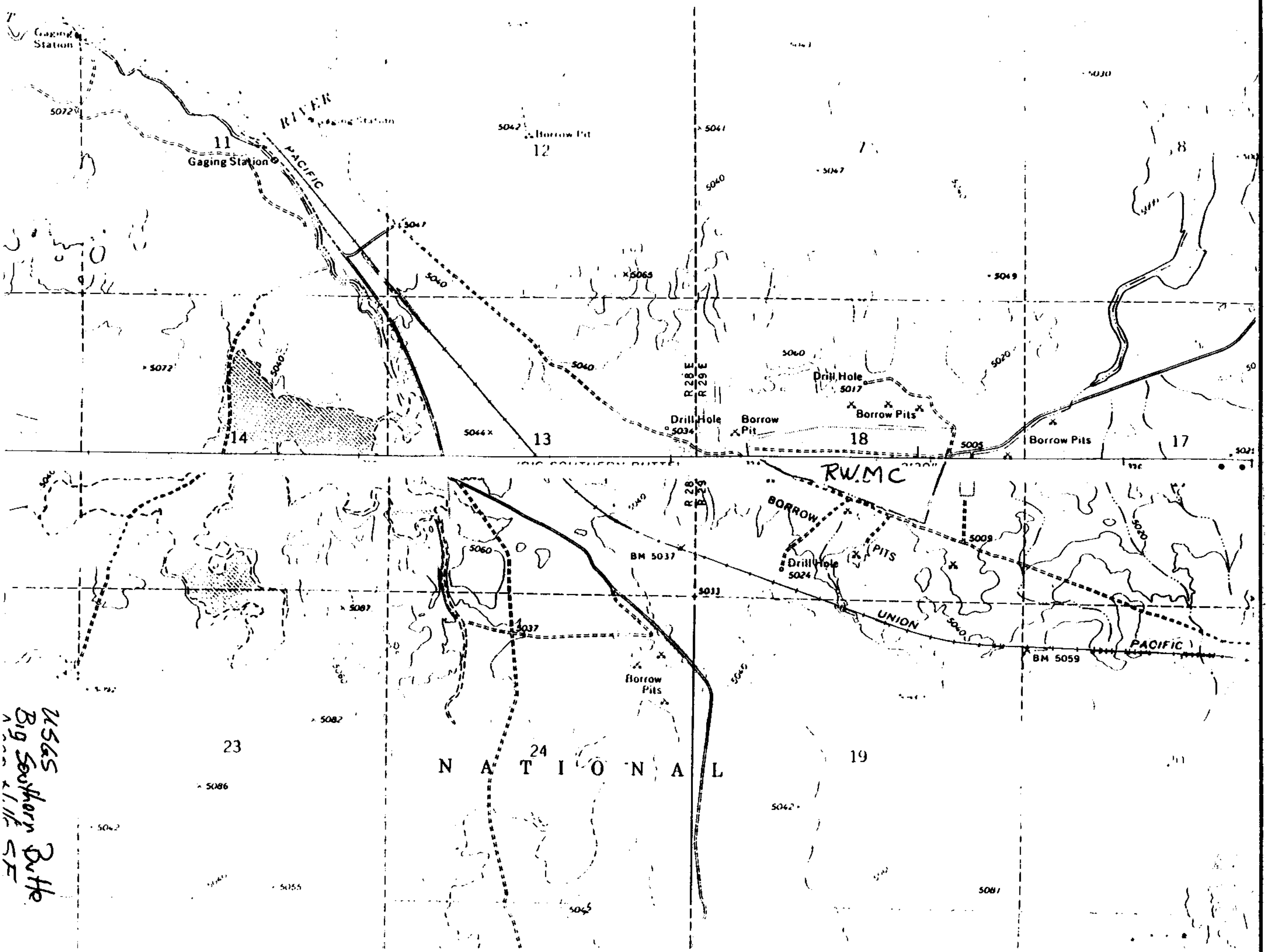


Figure 2.--Location of the study area and enlarged spreading areas A, B, C, and D

USGS 86-4204


N
U.S. Government Railroad
26
25
24
23
22
20
19
21
7
13132535
Test Reactor Area
Canal
Dirt road
Monroe Boulevard
Boulevard
River
Idaho Chemical Processing Plant
Lincoln
Canal
Canal
Canal
Dirt road
West Portland
Van Buren Boulevard
112° 55'
1
11
12
7
13
18
17
22
23
24
19
20
29
35
8

USGS 98-4065



Gaging Station
RIVER
Gaging Station
PACIFIC
11
12
13
14
5042
Borrow Pit
5041
5047
5040
5065
5049
5030
5072
5060
Drill Hole
5017
Borrow Pits
Drill Hole
5034
Borrow Pit
18
5005
Borrow Pits
17
5020
R 28 E
R 29 E
5044
RW.MC
BORROW
PITS
Drill Hole
5024
5009
BM 5037
5033
5060
5087
5037
Borrow Pits
UNION
PACIFIC
BM 5059
23
24
19
NATIONAL
5082
5086
5042
5055
5087
USGS
Big Southern Butte